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Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Experimental methods in Thermo-fluid Dynamics
Course code	45540
Scientific sector	ICAR/02
Degree	Master in Energy Engineering
Semester	2
Year	2
Academic year	2020/21
Credits	6
Modular	no

Total lecturing hours	36
Total lab hours	
Total exercise hours	24
Attendance	
Prerequisites	Basic knowledge of fluid mechanics
Course page	OLE

Specific educational objectives	Experimental methods in Thermo-fluid Dynamics is an optional course within the master in Energy Engineering and is aimed to the students showing particular interest in fluid mechanics. Some specific topics addressed only marginally in the basic courses of hydraulics and fluid mechanics will be addressed, in order to provide the students with the fundamental knowledge about experimental techniques and methods for fluid dynamics, heat transfer, turbulent flows, physical modelling. Within the tutorials and the laboratory works the students will have the opportunity to develop experiments and apply state-of-the-art techniques (LDA, PIV, PTV) to practical applications relevant to energy engineering.

Lecturer	Michele Larcher, Maurizio Righetti, Giuseppe Roberto Pisaturo
Scientific sector of the lecturer	ICAR/01 and ICAR/02 (08/A1)
Teaching language	English
Office hours	Whole week, on appointment
Teaching assistant *(if any)*	
Office hours	Whole week, on appointment

List of topics covered	The course will cover the following topics: - brief introduction to turbulence and statistics (brief mention); - the theory of similitude with practical applications to physical models and turbulent flows; - overview and practical applications of the major experimental techniques and methods in thermo-fluid dynamics (e.g. Particle Tracking Velocimetry, Particle Image Velocimetry, Laser Doppler Anemometry, Phase Doppler Anemometry); - contactless methodologies for measurements in turbulent flows.
Teaching format	Lectures in the class and tutorials in the laboratory; homework on the analysis of fluid mechanics experimental applications relevant to energy engineering.

Learning outcomes	By the end of the course, students are supposed to be able to: - *Knowledge and understanding:* (1) show the experimental techniques to be applied to turbulent flows/heat transfer; (2) develop an intuitive comprehension. - *Applying knowledge and understanding:* (3) give examples of real applications and practical problems to underline how the topics treated in the course are used within engineering activity. - *Making judgements:* (4) the ability to make autonomous judgements in the choice and comparison of the suitable tools for a proper design and development of a measurement campaign in thermo-fluid mechanics. - *Communication skills:* (5) communication skills to correctly and properly present the concepts acquired in the course and the results of the homework. - *Learning skills:* (6) Ability to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation.
Assessment	The examination of the course is based on oral questions about the contents of the course and on the presentation and discussion of the report on the experimental activities. The oral examination includes questions to assess the knowledge and understanding of the course topics and the communication skills.

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<table>
<tr><td></td><td>Formative assessment
<table><tr><th>Form</th><th>Length / duration</th><th>ILOs assessed</th></tr><tr><td>In class exercises</td><td>24 x 60 minutes</td><td>2, 3, 4, 6</td></tr></table>
Summative assessment
<table><tr><th>Form</th><th>%</th><th>Length / duration</th><th>ILOs assessed</th></tr><tr><td>Homework presentation</td><td>60%</td><td>15 minutes</td><td>1, 3, 4, 5, 6</td></tr><tr><td>Oral exam</td><td>40%</td><td>10 minutes</td><td>1, 2, 3, 4, 5, 6</td></tr><tr><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Assessment language</td><td>English</td></tr>
<tr><td>Evaluation criteria and criteria for awarding marks</td><td>Students will be evaluated on the base of an oral discussion (40%) and of the presentation and discussion of the homework (60%). At the oral part, knowledge and understanding of the topic (50%), the communication skills (25%) and the ability to summarize (25%) are assessed. At the presentation and discussion of the report, applying knowledge and understanding (30%), making judgments (25%), the communication skills (25%) and the learning skills (20%) will be assessed.</td></tr>
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Required readings	The topics will be sampled out of different books and scientific papers. Attending regularly the classes and specially laboratory activities is highly recommended. Some material will be made available in OLE.
Supplementary readings	M. Raffel, C.E. Willert, S. Wereley, J. Kompenhans, Particle Image Velocimetry, A Practical Guide, Springler Verlag 2007 M. Muste, Experimental Hydraulics: Methods, Instrumentation, Data Processing and Management, IAHR Monograph 2017 H. Oertel (ed.), Prandtl-Essentials of Fluid Mechanics, Applied Mathematical Sciences 158, Springer, 2010 Y.A. Çengel, & J.M. Cimbala, Fluid Mechanics – Fundamentals and Applications, 2006, McGraw-Hill J.C. Gibbings, Dimensional Analysis, Springer, 2011 B. Zohuri, Dimensional Analysis and Self Similarity Methods for engineers and Scientists, Springer, 2015 L.P. Yarin, The Pi-Theorem. Applications to Fluid Mechanics and Heat and Mass Transfer, Springer, 2012 A. Adami, I modelli fisici nell'idraulica, CLEUP, 1994 W.E. Langlois and M.O. Deville, Slow Viscous Flow, Springer, 2014